the current April, rendered conditions very favorable for prairie fires. The loss from these fires was confined to hay, range, and a few ranch buildings.

Steam-shovel operations were resumed on the St. Mary Project, Teton County, on April 12, the frost being out of the ground at that time. No time was lost on account of the weather during the remainder of the month.

Severe thunderstorms occurred in portions of Fergus County on April 5. Steven Strouf, who was working in his field 7 miles from Stanford, was killed. Near Kendall 3 horses were killed and the driver stunned. April thunderstorms of such severity are rare in this section.

The usual spring rise in the Missouri River made it necessary to suspend work on the Hauser Lake and Holter dams near Helena during the latter part of the month. The rise occurred rather earlier than usual this season, although the spring rains have been abnormally light.

Reports from flockmasters over the State are unanimous to the effect that this spring has, so far, been extremely favorable for the sheep industry. There has been practically no snow over the ranges and no severe storms have occurred. The warm weather has been favorable and the grass is from two weeks to a month further advanced than normal. Sheep are generally in excellent condition for the lambing season. Some lambs were dropped in April, under the most favorable conditions, but the lambing season is principally in May in this latitude.

The dry weather of April has caused some anxiety about the growth of grass during the coming months. The ranges are not as yet suffering, but wet weather during May and June will be required to carry them through the summer season.

Mr. F. F. Smith, United States Reclamation Service, reports that weather conditions on the Fort Shaw Unit have been exceptionally favorable for all kinds of construction work during the month of April, 1910. Only one light shower occurred. The temperature ranged from 26° to 88°.

At Glendive preparations for the coming irrigation season were carried on during the month. The grain crops throughout the valley are well started and large areas of sod are being broken.—*R. Frank Young.*

North Dakota.—The unusually high average temperature was principally due to high maximum temperatures.—*Orris W. Roberts.*

South Dakota.—While there was some delay and interruption occasioned by disagreeable and stormy weather, it was on the whole more favorable for farming, mining, railroad, and engineering work than is usually experienced in April. The grass on the ranges afforded good pasturage, and owing to the mild weather in March and the first of April vegetation was unusually advanced for the season. As a result the freezing weather after the 10th caused serious damage to tree and bush fruits and to the foliage of trees. The James and Missouri rivers were somewhat higher than usual for April, but the other streams, including those in the Black Hills, were about normal.—*S. W. Glenn.*

On the Belle Fourche Project there are ditches and laterals with sufficient water supply for about 50,000 acres. The water supply is sufficient for this season of the year,, but there is being stored in the Belle Fourche Reservoir about 50,000 acre-feet for use when the water supply falls off, which will probably not need to be drawn on until July 15.—*Chief Engineer, United States Government Irrigation Project, Belle Fourche, S. Dak.*

Altogether it has been about a normal Black Hills April. Streams about normal, with some snow banks on north sides of hills yet to melt, though not enough for an increase in water that will be noticeable.—*Timekeeper, Homestake Mining Company.*

* * * We experienced no trouble in the operation of trains, with the exception of a period during April 16, 17, and 18, between Watertown and Gettysburg, where several trains were annulled on account of a severe snowstorm. * * * We experienced no trouble with washouts. * * * —*Superintendent, Dak. and Minn. Div. C. & N-W. R'y, Huron, S. Dak.*

The weather for the month of April was favorable for live stock, but hard on timber and medium for agriculture.—*Superintendent Crow Creek Indian Agency, Crow Creek, S. Dak.*

The weather for the month of April has had no material effect either way on game and fish, to the best of my knowledge. Hunting was not the best up to the 10th, on account of the warm weather in March, causing all the waterfowl to go farther north earlier than usual in this section.—*State Game Warden, Watertown, S. Dak.*

Colorado.—The days were warm and the nights generally cool. Frosts were common and fruit interests suffered, especially during the night of the 15–16th. The snowfall was lighter than usual for April, and at most of the lower level stations there was practically none.—*F. H. Brandenburg.*

Nebraska.—The remarkably warm weather of March caused vegetation to start unusually early and much injury was done by the freezing weather in April, which was but normal and seasonable. Fruit was very largely in bloom and was seriously damaged, and only a small fraction of a normal crop can be expected. Winter wheat was considerable killed by unfavorable winter conditions and the continued dry weather further reduced the prospect of a crop. The dry soil caused oats to germinate unevenly and the growth was exceedingly slow. The soil was moist enough to allow plowing for corn to make normal progress.—*G. A. Loveland.*

Iowa.—The cold spells of the 15–18th and 23d–25th caused immense damage to fruit trees, at that time in blossom. Small grain was damaged by dry weather during the first half of the month and by frequent high winds. Farming operations were further advanced than usual on April 1. Practically all small grains were seeded before the middle of April, and nearly all the corn ground was ready for the planter by the close of the month. Considerable corn was planted during the second week, but the work was suspended after the 15th on account of cold weather. All streams were below the normal. There were no destructive storms reported and the number of thunderstorms was less than the average for April.—*G. M. Chappel.*

Kansas.—This is the 6th successive month with unusual weather conditions. It was the driest April in 24 years, and but three Aprils in the period have been warmer. It is the second time that the prevailing direction of the wind was from the northwest, and there has been but one April with a greater wind movement. The rivers continued low and nearly stationary. The mild, dry weather permitted farming operations to be carried on uninterruptedly, but the temperature following the 15th gave a decided check to the growth of all vegetation. The weather conditions were favorable to building operations. Transportation interests were not adversely affected by the weather, except that the gale of the 23d delayed railroad trains more or less.—*T. B. Jennings.*

Missouri.—April, 1910, was decidedly unfavorable from the view point of the agriculturist, and also from the physiological side. It is interesting to note that the mean temperature was more than 1° cooler than that for March, and that this phenomenon has occurred but twice in about 30 years. The warm weather during March and the first half of April advanced fruit and vegetation fully a month ahead of the average and the fruit was particularly promising. The freeze of the 24–25th caused an estimated loss of $2,500,000 to the fruit crop in this State. The warnings issued by the Weather Bureau were generally heeded and orchards were heated freely during the nights of the 23d and 24th, but the continued low temperature, rather high wind, and driving snow compelled the orchardists to abandon the work. A thunderstorm of marked energy, partaking somewhat of the characteristics of a tornado, occurred at Macon during the afternoon of the 4th. There was some local damage to buildings, trees, fences, etc., but no lives were lost.—*George Reeder.*

The Reclamation Record states that the irrigation season opened on the Sun River Project, Montana, April 11; Shoshone Project, Wyoming, April 17; North Platte Project, Nebraska–Wyoming, April 17; and on the Huntley Project, Montana, on April 26. The date for the Sun River Project was about one month earlier than usual.

SNOW CONDITIONS IN THE MOUNTAINS IN MONTANA AND THE PROSPECTIVE WATER SUPPLY.

In general, the snowfall during the month was much less than normal on the high ranges, the warm weather materially lessened the stock of winter snow, and considerable anxiety prevails concerning the flow during the remainder of the season. The stream flow during April was generally above normal, due to the unusually warm weather. In a majority of the streams the flow continued undiminished at the end of the month.

Reports would show conditions to be favorable over the watershed of the Musselshell and a portion of the Jefferson River Basin. At scattered points along the Divide, on small tributaries of the Missouri, conditions are reported to be favorable for the normal run-off during the remainder of the season.

The consensus of opinion is that the snow supply is below normal and that the later run-off will be below normal over the upper headwaters of the Jefferson and the tributaries to the stream from the north, the Yellowstone, lower tributaries of the Big Horn, Gallatin, Milk River, Sun River, and the upper Madison River tributaries.

THE FLOOD OF JULY 10-20, 1909, IN THE LOWER MISSOURI VALLEY.

By J. WARREN SMITH, M. S.

A very disastrous flood occurred in the lower Missouri Valley in July, 1909. At Glasgow, Mo., the river was only 0.8 foot below the high water mark of June 5, 1903, and the lower Missouri River was generally higher than ever before recorded in July.

The Marais des Cygnes River in eastern Kansas was higher than ever before recorded, and the Grand River and its branches in northern Missouri had the worst flood in its history. In the Grand River Valley the water rose with such remarkable rapidity that very little could be done to save property, and much loss resulted.

The flood in the Marais des Cygnes and Grand rivers was due entirely to heavy local rains, while the high water in the Missouri was caused by the flood of water from the smaller rivers and streams pouring into a river already bank full.

The flood was so unusual in many respects that it has been thought wise to show the rainfall in detail by means of charts, as well as the rapid rise in the rivers by means of the graphs in figs. 5 and 6.

The river gage stations in the lower Missouri River and its tributaries are shown on the accompanying figures. Arlington is on the Gasconade River, Bagnell and Osceola on the Osage, Ottawa on the Marais des Cygnes, the main branch of the Osage, Brunswick is near the mouth of the Grand River, Trenton on the Thompson Fork of the Grand, and Pattonsburg on the main fork of the Grand River below the mouths of the East and West forks.

There were no river gage stations in operation at the time of the flood at Brunswick, Trenton, Pattonsburg, Osceola, or Ottawa, but stations have been established since and the height of the water during the flood determined.

Fig. 1 shows the rainfall in the eastern part of the Missouri watershed on July 3 and 4. It will be seen that the fall was moderately heavy in the upper James, Big Sioux, Floyd, and Little Sioux valleys in South Dakota and Iowa, and in the lower Platte in Nebraska. Heavy local rains fell also in North Dakota and Montana, although not over large areas.

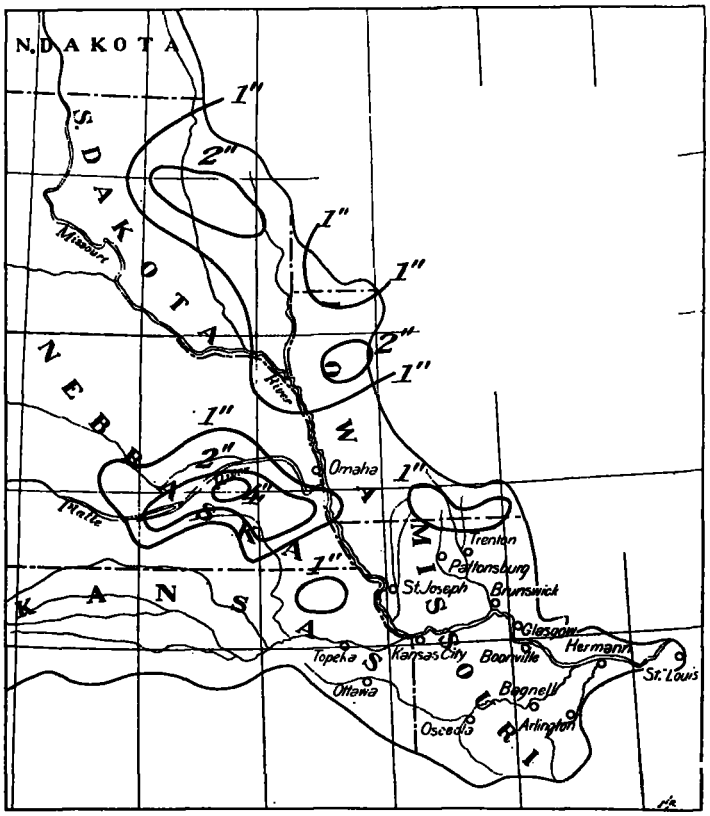

FIG. 1.—Rainfall over the lower Missouri Valley, July 3 and 4, 1909.

Fig. 2 shows the rainfall for the 5th and 6th, the greatest amounts occurring in northern Missouri, southwestern Iowa, southeastern Nebraska, and northeastern Kansas. At Bethany, Mo., on the Big River, a branch of the Grand that flows in below Pattonsburg, the rainfall for the 2 days was 10.71 inches. It was over 7 inches at Grant City, Mo., and Lamoni and Mount Ayr, Iowa, in the upper Grand Valley, and 8.40 inches at Allerton, Iowa, near the head of one of the branches of the Chariton River and of the Locust and Yellow forks of the Grand.

Fig. 3 shows the fall for the 7th and 8th, and that it was heaviest in eastern Kansas and western Missouri in the Marais des Cygnes Valley. The rainfall at Osage City, Kans., for the 2 days was 10.03 inches, and at Amoret, Mo., 8.24 inches.

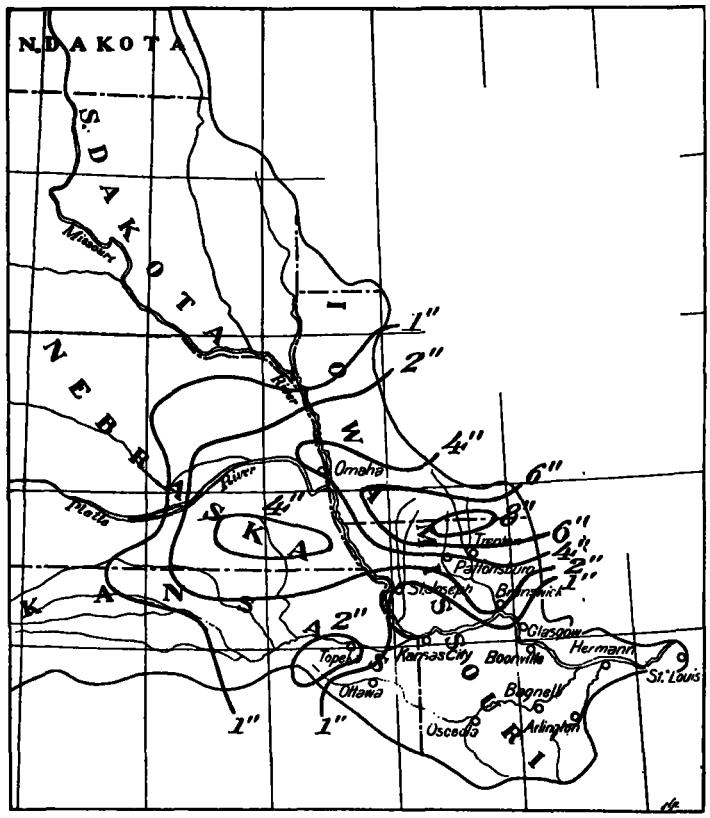

FIG. 2.—Rainfall over the lower Missouri Valley, July 5 and 6, 1909.

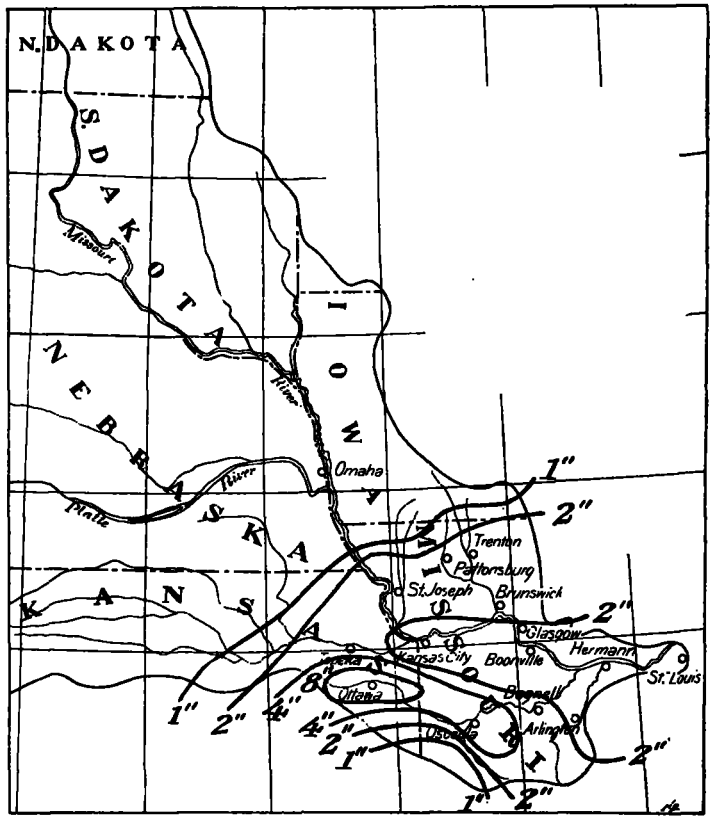

FIG. 3.—Rainfall over the lower Missouri Valley, July 7 and 8, 1909.

Fig. 4 shows the rainfall on the 10th and 11th. There was very little rainfall on the 9th, but on the 10th and 11th the fall was moderately heavy in the Osage Valley, as may be seen from this chart.

One man, in a large meadow near Trenton, saw the flood of water moving toward him in a wave 2 to 3 feet high across the whole meadow. He thought at first it was the water pouring over a ridge in the field, but soon saw it was advancing rapidly.

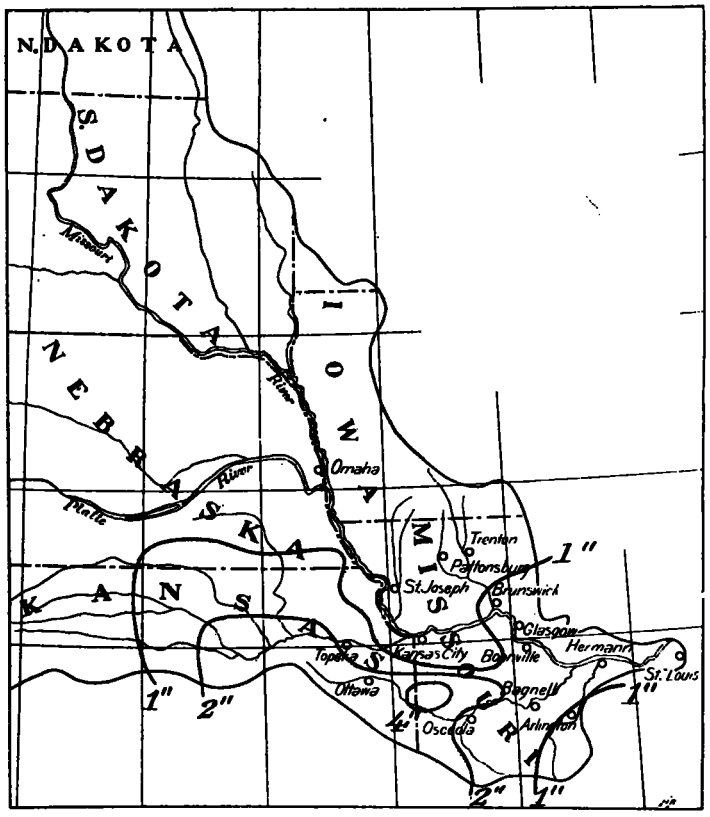

FIG. 4.—Rainfall over the lower Missouri Valley, July 10 and 11, 1909.

The town of Pattonsburg is on an alluvial plain in a large bend of Grand River and is about 2 miles from it. The Big River is east of Pattonsburg and flows into the Grand below the town. The Big River is very apt to overflow its banks and a dike has been built east of Pattonsburg to keep the rising water out of that town.

Big River usually rises more quickly and more rapidly than the Grand and when it went out of its banks in the flood and began to approach the top of the dike as many men as could be gotten together were hastily sent to strengthen and raise the dike. The water rose so rapidly, however, that they were obliged to discontinue work, abandon their tools, and leave the dike to prevent being washed off. The water poured over the dike and railroad track and caused a great deal of damage by washing in the main street of Pattonsburg.

Very soon, however, the Grand River overflowed its banks and the backwater from this river spread into the town and prevented further damage by washing from the waters of Big River. Many of the residences in Pattonsburg are but one story in height and the water reached to the eaves in most cases. There was not a building in town that was not flooded. The people had no chance to move or protect their furniture, even in the 2-story houses, and in many cases were not able to reach other places of safety because of the rapid rise of the water. Many persons were forced to remain on the roofs of their dwellings, or in the tops of near-by trees all night.

The water overspread the entire town from 4 to 12 feet in depth, but south of this town, where the valley is narrower, it was from 20 to 30 feet deep.

A study of individual reports from cooperative observers shows that the excessive rainfall progressed from north to south, and probably at about the rate of the flow of the water, at least over the upper watersheds. (See figs. 1 to 4.)

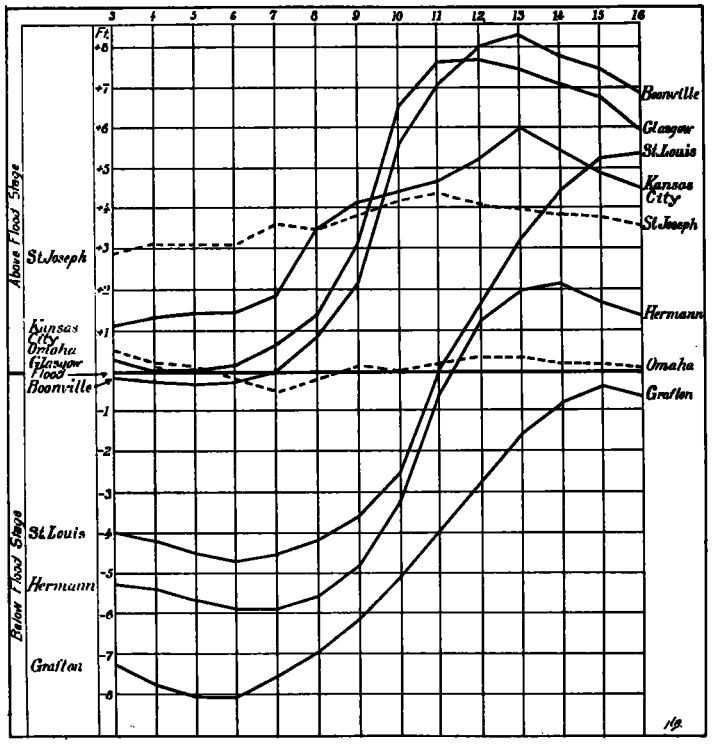

FIG. 5.—River stages, amounts above or below the flood stage in feet July 3 to 16, 1909. Missouri and Mississippi rivers.

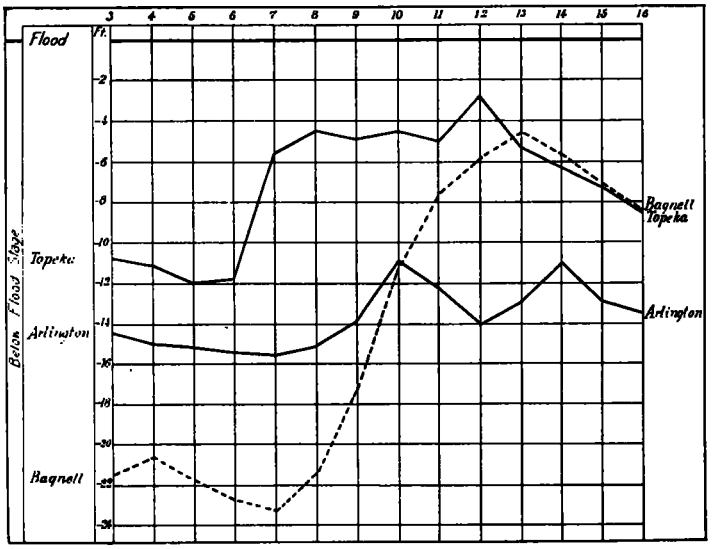

FIG. 6.—River stages, amounts above or below the flood stage in feet, July 3 to 16, 1909, on the Kansas, Osage, and Gasconade rivers.

At Trenton, Mo., the highest water was 27.8 feet on the 6th, 7.8 feet above flood stage. At Pattonsburg it was 35.6 feet, 12.6 feet above flood, on the 7th. At Brunswick, however, the highest water was not until the 9th, although the water rose very rapidly before that date and poured over the bank and into the Missouri River like a great cataract along about a half-mile front. The highest water at Brunswick was 23.0 feet, or 13 feet above the flood stage. At each of these places, and in general in the Grand watershed, the water was the highest ever known.

The rainfall over the upper part of the Grand River Valley was very heavy indeed, but it seems to the writer that the re-

markably rapid rise in this river and the extreme height that it reached may be explained, in part, by the fact that the excessive rainfall moved down the river valley, accompanying and intensifying the crest of the flood.

The rainfall at Osage City, Kans., in the upper Marais des Cygnes, was nearly as heavy as at any station in the Grand Valley, and although the water was the highest ever known at Ottawa, Kans. (35.3 feet, or 11.3 above the flood stage), it was not so high at Osceola, Mo., as has been before recorded, and at Bagnell it did not reach to within 4 feet of flood stage. To be sure the area of excessive rainfall did not cover so large a per cent of the watershed, but it is plainly shown that the area of excessive fall moved across instead of down the valley.

The weather maps during the period of heavy rains show an area of moderately high pressure spreading from the northwest slowly over the Lake region and middle Atlantic coast, while a poorly-defined depression moved over the central Rocky Mountain region to western Kansas on the 4th, then held fairly stationary until the 7th. It was then met by another poorly-defined area from the northwest, after which it dissipated.

A report of the damage done by the flood, charts of the movements of the high and low pressure areas, and the daily rainfall figures may be found in the MONTHLY WEATHER REVIEW for July, 1909, and need not be repeated in this article.

In figs. 5 and 6 graphs are given showing the rise at the different river gage stations at St. Louis and Grafton, and on the Missouri River and its lower tributaries. Instead of showing the actual river gage readings, the figures show the distance below or above the flood stage at each point, from July 3 to 16.